

**COMPOSITIONAL INFORMATION FOR THE MOON: SOME CHARACTERISTICS OF CURRENT NEAR-IR SPECTRA (TELESCOPIC AND LABORATORY) - Carle M. Pieters, Dept. Geological Sciences, Brown University, Providence, RI 02912**

**Introduction.** During the Apollo program the spectral reflectance characteristics of a variety of lunar samples were measured in the laboratory by John B. Adams. Results of these measurements were reported in a series of papers by Adams and McCord (e.g. PLSC of 1970, 71, 72, 73). Most of these studies were directed toward understanding the nature and composition of lunar soils, since the vast majority of remote measurements are derived from the uppermost surface soils. These laboratory measurements were essentially discontinued with the close of the Apollo program. Later, in the late 1970's, telescopic instruments were developed that allowed high precision near-infrared spectra, comparable in spectral resolution to the laboratory data, to be obtained for individual lunar areas 3-20 km in diameter using telescopes at the high-altitude Mauna Kea Observatory (1). For the last decade near-infrared spectra for small lunar areas have been painstakingly obtained by researchers from the Univ. of Hawaii and from Brown University. Such telescopic spectra, with the 'ground truth' foundation from lunar samples, have been used extensively by these lunar scientists to address a multitude of problems in lunar science. Summaries of the compositional information inherent in the telescopic spectra can be found in (1,2,3). Much of the near-infrared spectral reflectance data from both laboratory and telescopic measurements have recently been compiled in comparable formats and an initial comparative assessment of the available data using selected measured spectral parameters has been made. The objective is to develop a framework for the systematics of lunar near-IR spectra in order to better interpret spectra of unknown materials in terms of useful compositional information.

**Spectral Parameters.** Each spectrum was first classified according to its general character. Major categories indicated in the key accompanying Figures a-d account for about 2/3 of the data. A variety of parameters sensitive to mineralogy and alteration products were measured for each spectrum: center of an absorption band near 1  $\mu\text{m}$ , strength of the band, band width, band symmetry, continuum slope (near the 1  $\mu\text{m}$  band), etc. These particular properties were chosen because important lunar minerals (high- and low-Ca pyroxenes, olivine, glass, plagioclase) have characteristic absorptions that affect the strength and nature of these parameters in diagnostic ways (1,2,3). Examples of the relation between some of these spectral parameters for the two collections are shown in figures a-d. Each spectrum was also assigned a relative quality factor from 1 to 5; only quality 1 and 2 have been used in these figures.

**Telescopic Data.** The current data base includes almost 350 individual spectra for about 210 areas 3 to 15 km in diameter (independent measurements are required for most areas). If data scattered among researchers is included, the lunar collection could be about 1/3 larger. Although some attempt has been made in recent years to assure most important geologic units are included in the collection, the survival of data acquisition programs depends on productive science, and the data collection is necessarily biased toward areas studied for specific topics (mare soils, Copernicus and its rays, highland craters, etc.).

**Laboratory Data.** The Adams' spectra include almost 420 spectra of ~150 lunar samples. About 70% are lunar soils representing all Apollo sites, as well as Luna 20 and 24. Although the scale of a laboratory sample is about  $10^6$  times smaller than the area of telescopic measurements, the two types of data are directly comparable for the relatively well-mixed lunar soils. However, for lunar rocks and minerals, and especially for breccias, the collection of sample spectra is incomplete due to the difficulty of obtaining or identifying materials from limited samples that are representative of a rock, a site, or even the moon as a whole. Not all lunar rock types identified are represented by sample spectra.

**Comparisons.** The two collections are not expected to be entirely similar for the reasons mentioned above concerning completeness. A few well-known lunar spectral properties are evident in both, such as the systematic variation in pyroxene composition (detected by band position and strength) between the highlands (Lo-Ca) and mare (Hi-Ca). Note, however, that an additional gabbroic (Hi-Ca px) component can be detected (longer band center) in many highland craters of Fig. d(3). As an example of

compositional inferences, consider the glassy samples (such as 74220, 15401 and a synthetic Apollo 12 glass) which systematically exhibit wider bands than the main trends of rocks and soils in Fig. a. The pyroclastic mantling material at Aristarchus, Sulpicius Cellus, and Sinus Aestuum exhibit similarly broad bands, implying Fe-bearing glass deposits (4). Olivine, such as that at Copernicus' central peak (CP) has similar properties, but can often be distinguished from glass by other characteristics such as albedo. The region marked 'OP' on Fig b and d include soils from the young Hi-Ti basalts of the western maria. These represent soils for which no samples exist (dotted areas on Figs. a and c) but which clearly contains substantial olivine or glass (5).

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